

Crop Wild Relatives Conservation and Use

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**European Parliament's Committee on Agriculture
and Rural Development :**

Genetic diversity, conservation and crops wild relatives

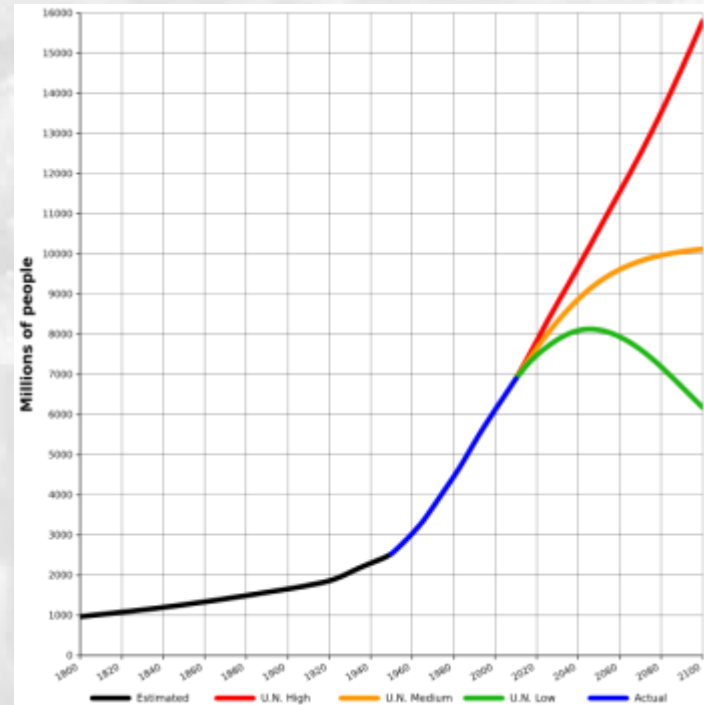
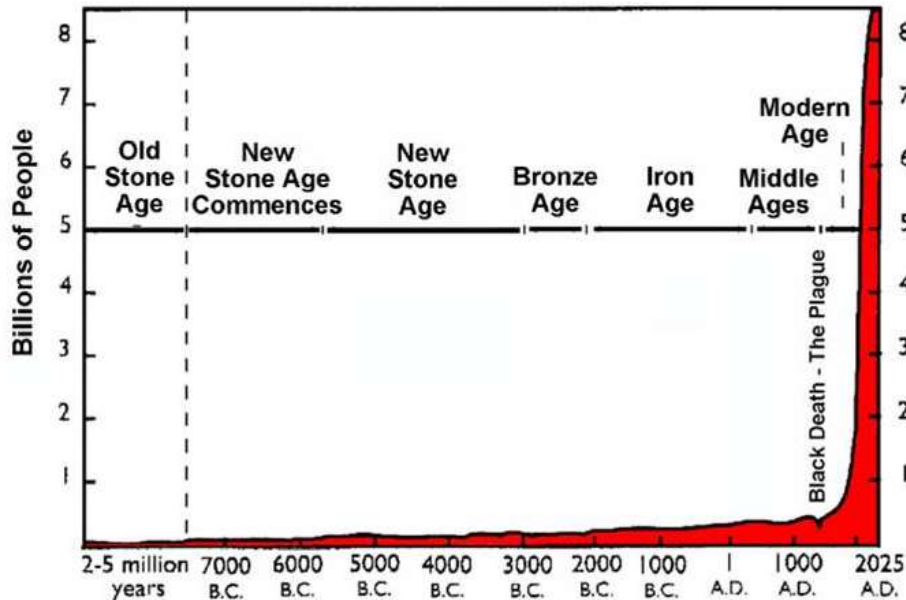
7 December 2017, Brussels, Belgium

The challenge

We need to feed the expanding human population!

- 7.55 billion in 2017, 78% live in developing countries (07/12/17)
- 9.8 billion by 2050, 86% in developing countries (UN, 2017)

World Population Growth Through History



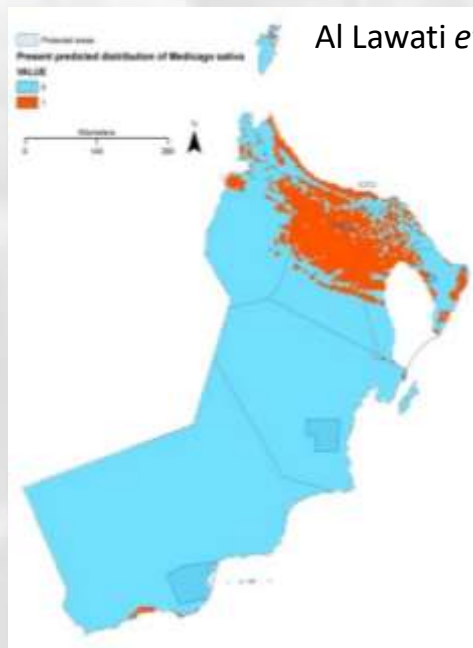
16 billion

10 billion

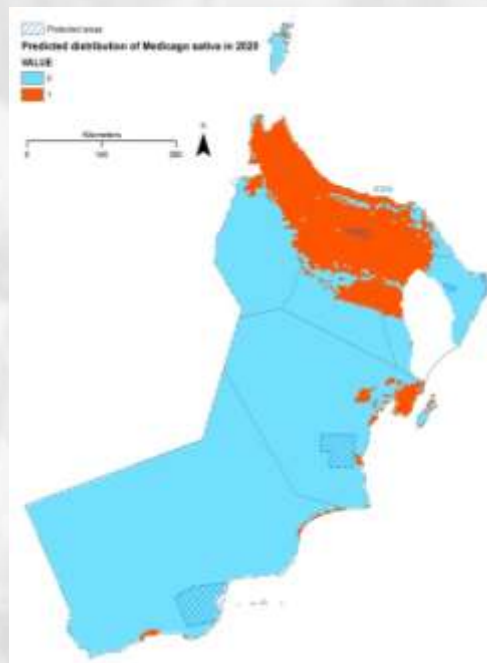
6 billion

Climate change

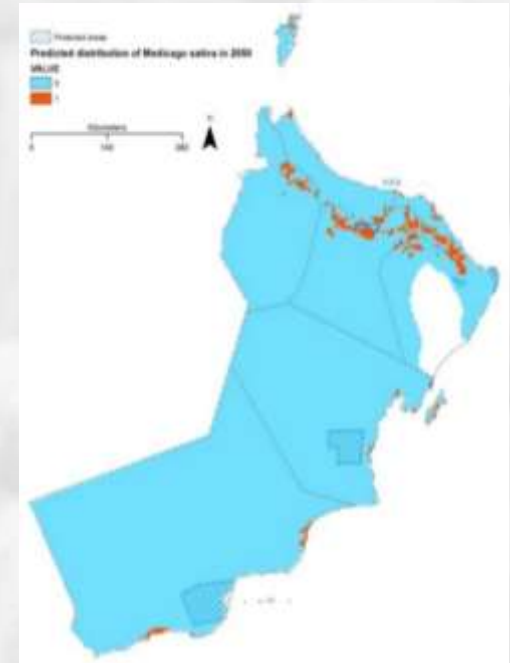
- To feed the human population in 2050 we will require food supplies to increase by 60% globally, and 100% in developing countries (FAO, 2011)
- While climate change may reduce agricultural production by 2% each decade this century (IPCC, 2014)



2015 @ 12%/Oman



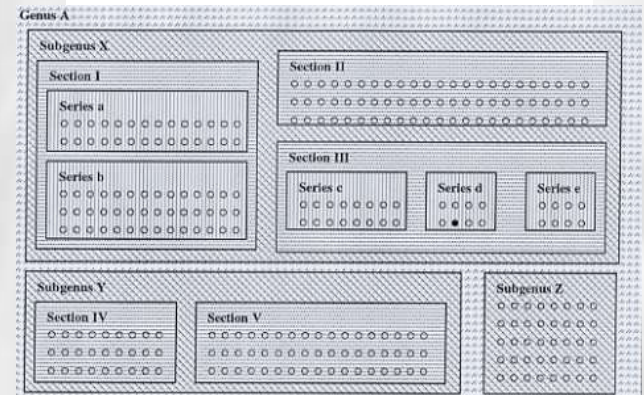
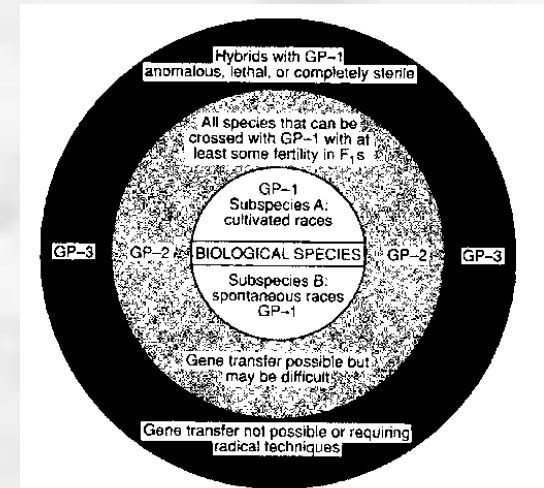
2020 @ 17.4%/Oman



2050 @ 2.3% of Oman

What are crop wild relatives?

- Crop wild relatives (CWR) are wild plant species closely related to crops, including wild **ancestors**
- They have an indirect use as **gene donors** for crop improvement due to their relatively close genetic relationship to crops
- They are an important socio-economic resource that offer **novel genetic diversity** required to maintain future food security



Broad definition:

CWR = all taxa within the same genus as a crop

Narrow definition:

A crop wild relative is a wild plant taxon that has an indirect use derived from its relatively close genetic relationship to a crop; this relationship is defined in terms of the CWR belonging to gene pools 1 or 2, or taxon groups 1 to 4 of the crop

Value of CWR: as a source of adaptive traits

CWR	Trait
<i>Aegilops tauschii</i>	Rust
<i>Ae. tauschii</i>	Sprouting suppression
<i>Ae. tauschii</i>	Wheat soil-borne mosaic virus, wheat spindle-streak mosaic virus
<i>Ae. tauschii</i>	Agronomic traits, yield improvement
<i>Ae. tauschii, T. turgidum</i>	Yellow rust and leaf rust
<i>Ae. tauschii, T. turgidum</i>	Water-logging tolerance
<i>Ae. variabilis</i>	Powdery mildew resistance
<i>Ae. variabilis</i>	Root-knot nematode resistance
<i>Ae. ventricosa</i>	Cyst nematode resistance
<i>Ae. ventricosa</i>	Eye spot resistance
<i>Agropyron elongatum, Ae. umbellulata</i>	Leaf and stem rust resistance
<i>Ag. elongatum</i>	Drought tolerance
<i>Agropyron sp.</i>	Frost resistance
<i>Secale cereale</i>	Yield improvement
<i>Triticum dicoccoides, T. timopheevii, T. monococcum, Ae. speltoides</i>	<i>Fusarium</i> head blight
<i>T. monococcum</i>	Stem rust
<i>T. turgidum subsp. dicoccoides</i>	Protein quality improvement
<i>T. turgidum subsp. dicoccoides</i>	Powdery mildew
<i>T. turgidum subsp. dicoccoides</i>	Stem rust
<i>T. urartu</i>	Powdery mildew
<i>Thinopyrum bessarabicum</i>	Salt resistance
<i>Th. ponticum</i>	<i>Fusarium</i> head blight resistance
<i>Thinopyrum sp.</i>	Greenbug resistance

Aegilops speltoides (B-genome)



Wheat



\$115 billion toward increased crop yields per year (Pimentel *et al.*, 1997; PWC, 2013 for 29 crops)

CWR are threatened and poorly conserved

Threat

IUCN Red List assessments of 572 native European CWR in 25 Annex I priority crop gene pools

- 16% of the species assessed are threatened or Near Threatened and 4% are Critically Endangered

Conservation

ex situ CWR ≈ inadequate:

- CWR represent 10.5% of total germplasm accessions
- Castañeda *et al.* (2016) reviewed global *ex situ* holdings found
 - ≈ ⅓ unconserved (no accessions in genebanks)
 - ≈ ⅓ poorly conserved (<10 accessions)
 - 72% are a high priority for collection

In situ CWR ≈ virtually non-existent:

- Many CWR are found in existing *in situ* protected areas, but they are not being actively monitored and managed
- Only a handful of CWR active genetic reserves have been established: *Triticum* CWR in Israel; *Zea perennis* in Mexico; *Solanum* CWR in Peru; wild Coffee CWR in Ethiopia; and *Beta patula* in Madeira
- None meet Iriondo *et al.* (2012) standard for *In situ* CWR conservation

European Red List of Vascular Plants



Kell *et al.* (2012) Red listed 571 European species



In situ and *Ex situ*

Policy context

- CBD Strategic Plan agreed in Nagoya (2010) – Target 13 of 20

"Target 13. By 2020, The status of crop and livestock genetic diversity in agricultural ecosystems and of wild relatives has been improved. (SMART target to be developed at global and national levels) In addition, *in situ* conservation of wild relatives of crop plants could be improved inside and outside protected areas."
- CBD Global Strategy for Plant Conservation 2011 – 2020 (2010) – Target 9 of 16

Target 9: 70 per cent of the genetic diversity of crops including their wild relatives and other socio-economically valuable plant species conserved, while respecting, preserving and maintaining associated indigenous and local knowledge.
- UN Millennium Development Goals highlighted the need of eradicating extreme poverty and hunger = Goal 1, 2 and 3, but particularly 2.5



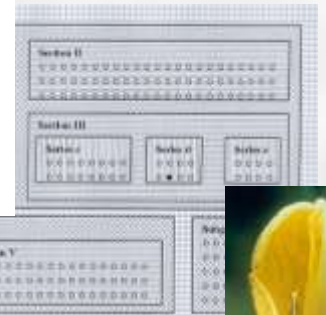
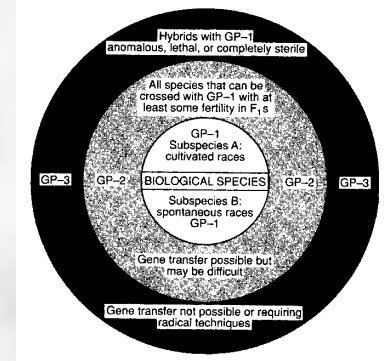
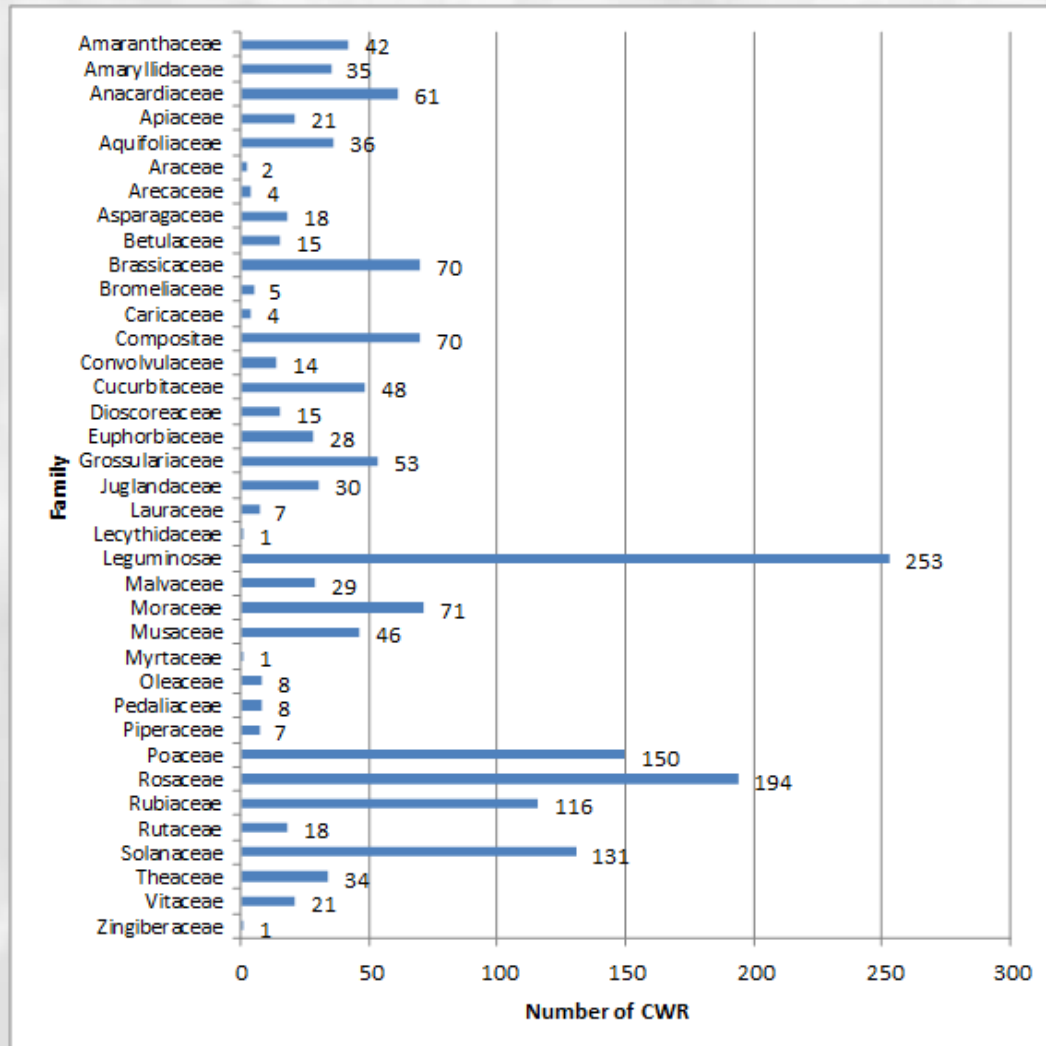
Vavilovia formosa:
CWR of garden pea

A proposal: towards a global CWR Conservation Strategy

- Global Crop Diversity Trust project with Norwegian Gov. funding
- Primarily use orientated, but some funding for *ex situ* collecting in first 6 years:
 1. List of gene pools and taxa to collect 92 genera with crops
 2. Ecogeographic data collection
 3. Gap analysis using Maxted *et al.* (2008) / Ramírez-Villegas *et al.* (2010) methodology
 4. Field collection
 5. *Ex situ* storage



Global Priority CWR taxa



1,667 priority CWR taxa from 194 crops

- 37 families
- 109 genera
- 1,392 species
- 299 sub-specific taxa

Vincent *et al.* (2012)

<http://www.cwrdiversity.org/checklist/>

Global CWR Conservation

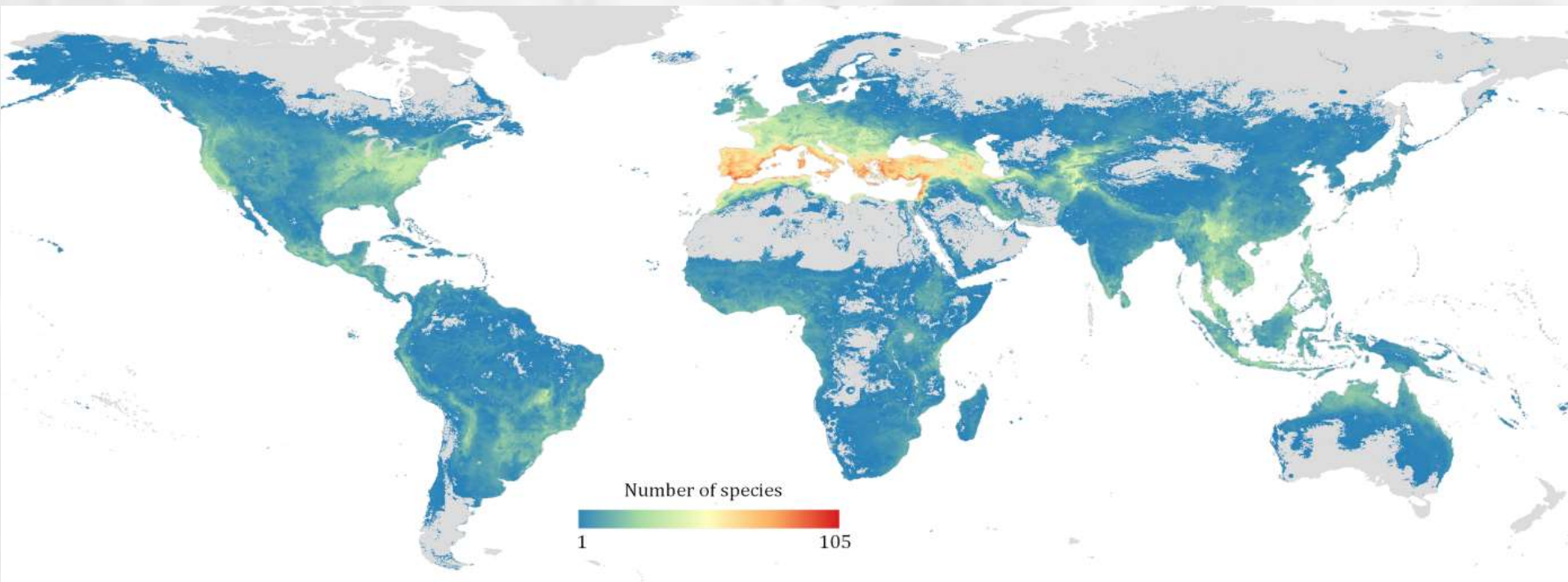


Figure 1. Species richness map for the priority CWR related to 194 crops at five arc minutes resolution (Vincent *et al.*, 2017).

Global CWR Conservation

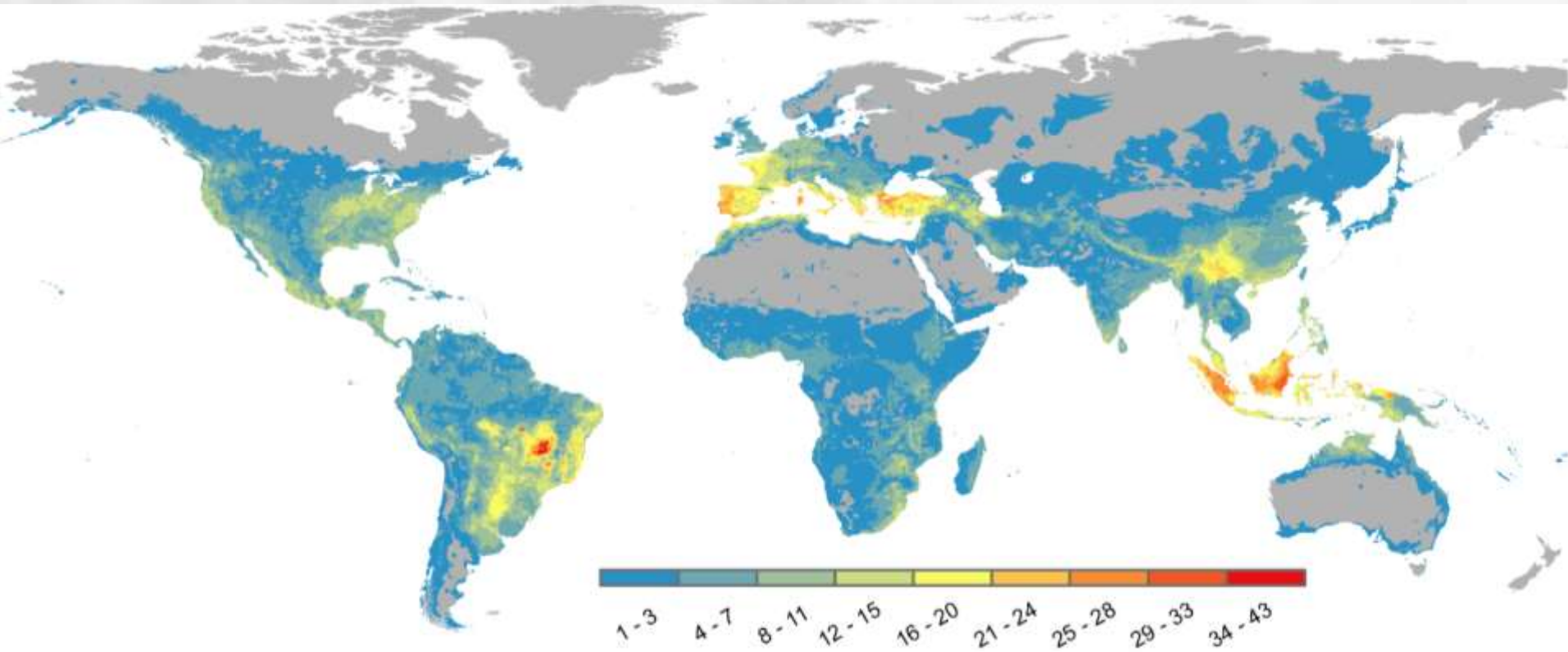


Figure 2. Global collecting hotspots for High Priority CWR for 76 crop gene pools (Castañeda-Álvarez *et al.*, 2016).

Global CWR Conservation

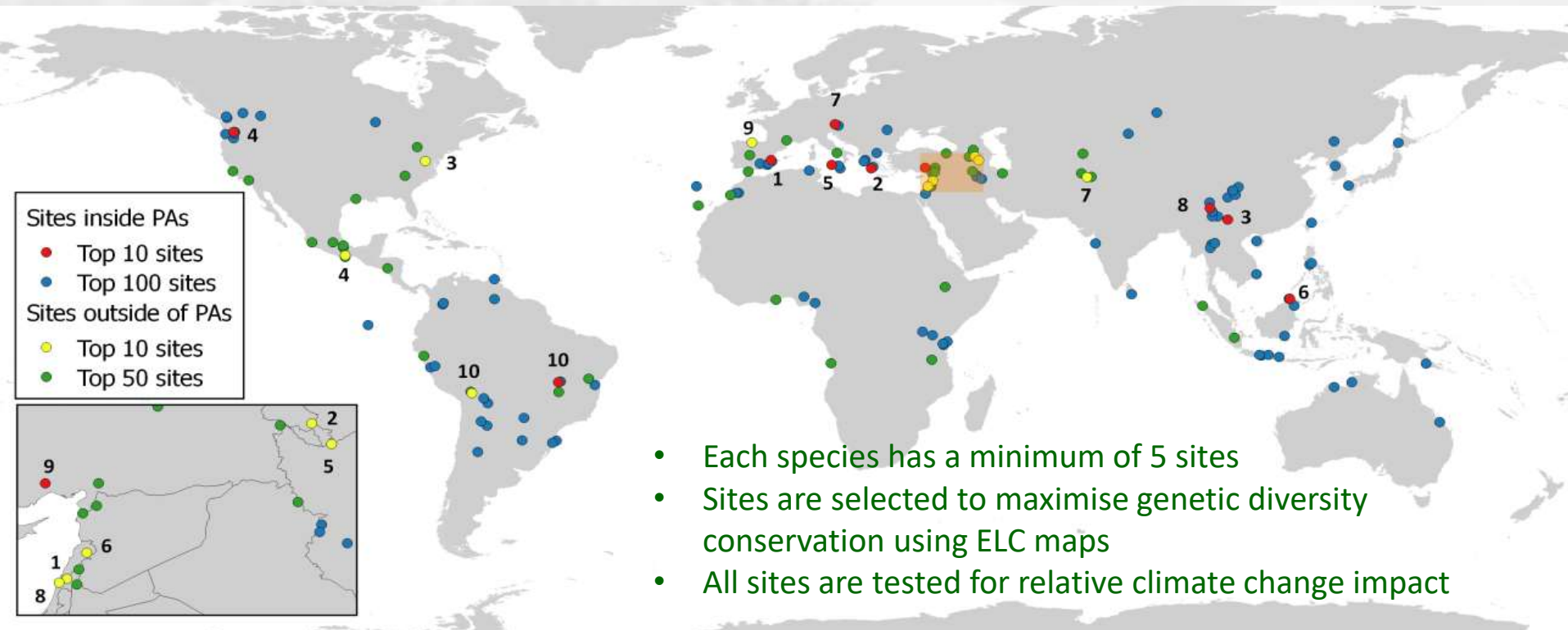


Figure 3. Top 150 sites for global *in situ* CWR conservation (PA and non-PA), with magnification on the Fertile Crescent and Caucasus (Vincent *et al.*, 2018).

European CWR Conservation

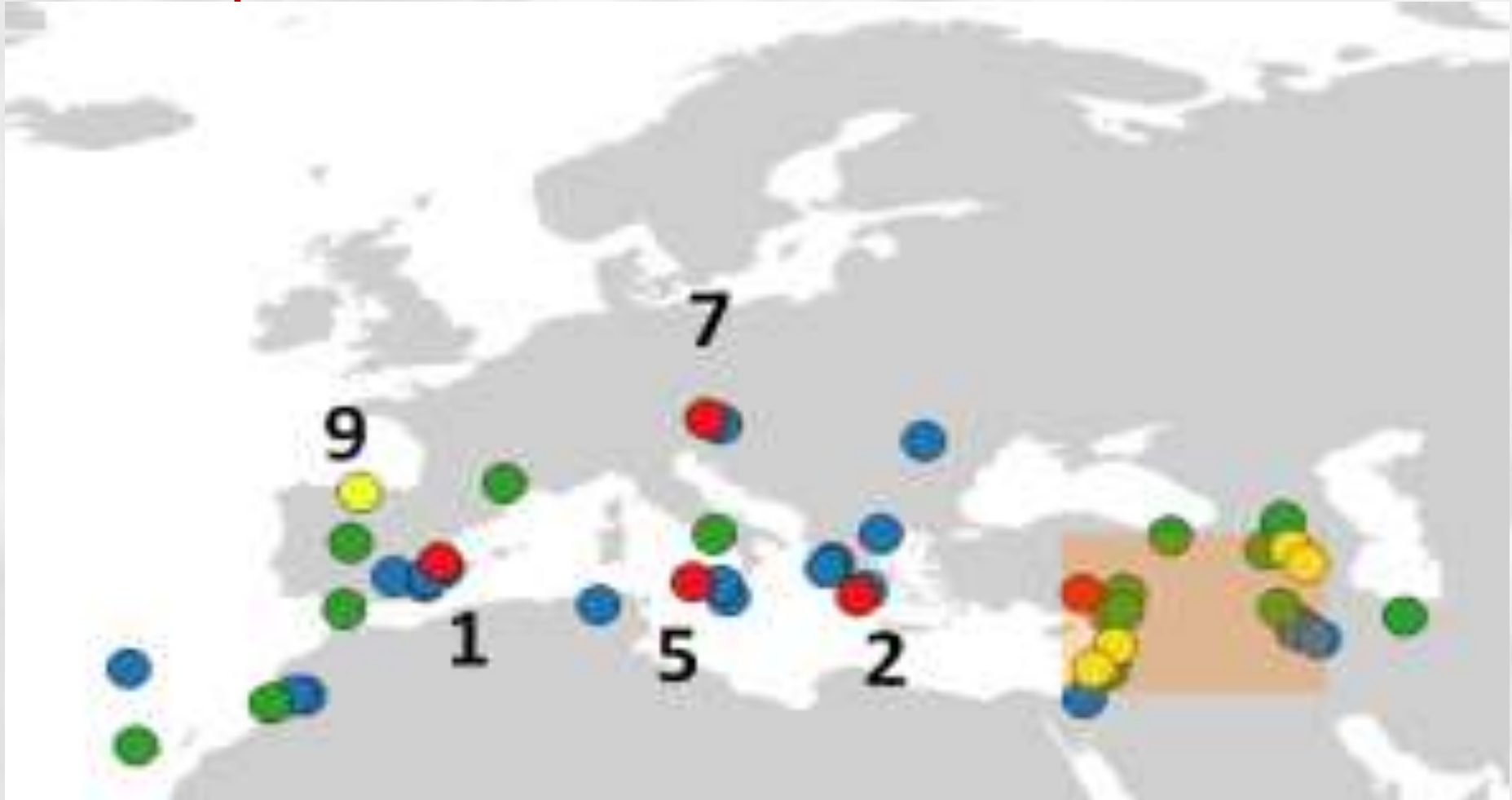
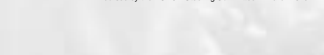
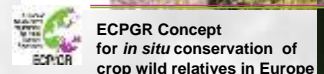
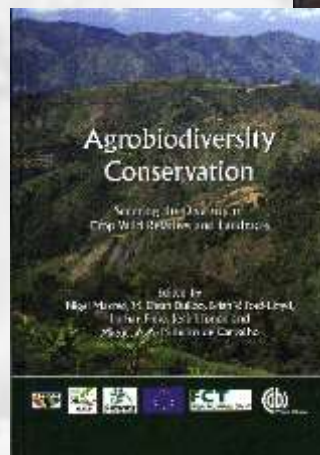


Figure 4. Top 45 out of 150 global *in situ* CWR conservation are found in Europe (Vincent *et al.*, 2018).

ECPGR Wild Species Conservation WG

Major achievements:

- Raising professional and public awareness
- Specific projects
 - PGR Forum
 - AEGRO
 - PGR Secure
- Publication of methodologies
- Concept (and background document):
ECPGR Concept for In situ Conservation of crop wild relatives in Europe
- Establishment of a community of experts



Farmer's Pride

HORIZON 2020 – SFS - 04 [2017] New partnerships and tools to enhance European capacities for *in situ* conservation

Coordination and support action to build a network(s) of *in situ* (including on-farm and on-garden) conservation sites and stakeholders in order to develop new partnerships between the conservation, farming, gardening and breeding sectors and with the wider public

Deliverables:

- Improved knowledge of the status and characteristics of CWR (/ LR) in Europe
- Durable network and partnerships between *in situ* conservation stakeholders
- Integration of national and European *in situ* conservation strategies
- Joined up *in situ* and *ex situ* conservation efforts
- Raised awareness of wealth of CWR / LR resources in Europe
- Increased use CWR / LR resources in breeding activities

Consortium: 19 European partners (conservation NGO, farmer's NGO, national, regional and international formal sectors, breeders, social scientists, media experts, protected area managers, genebanks and academics) + 20 Farmer's Pride Ambassadors



Wild chives, *Allium schoenoprasum*

The most important deliverable of Farmer's Pride is: a European Network of sites and stakeholders to conserve in CWR and LR diversity but there is no policy or legislative context for such a network

Actions required: Bridging gaps between stakeholder communities

Gaps between

- Planning and actual implementation of conservation priorities e.g. PGR Secure experience;
- Conservation *in situ* and *ex situ*, e.g. 99% on *ex situ*;
- Existing sectorial networking between biodiversity and agrobiodiversity stakeholders;
- Implementation of local, national, regional and global CWR conservation;
- Conservation of CWR diversity, characterization, and its supply and end-user application;
- Cross community awareness, valuation, governance and policy related to CWR conservation and use.



Aegilops speltoides (B-genome)



Wheat



Imperative to bring diverse stakeholder communities together to plan and implement systematic conservation!

Actions required: Resolving the *in situ* CWR conservation / use problem

- Conventionally CWR are obtained by breeders, farmers and other users from *ex situ* genebanks, but does this unnecessarily limit use?
- Argue that *CWR in situ* genetic reserves is untenable without active link to user – users will only sustain conservation if it is seen as useful;
- How?
 - Novel omics approaches to characterization and evaluation;
 - Predictive characterization for mining genetic resources;
 - End user-orientated informatics (e.g. GLIS + extension).
- Establish a *modus operandi* for the routine use of CWR diversity found in *in situ* genetic reserves!

Beta vulgaris subsp. *maritima*



Sugarbeet



Actions required: Establishing a European policy context for CWR (+GRFA) conservation



CWR discovered and almost lost?

- In 1987 near Cavus, Antalya province, Turkey while collecting for food, fodder and forage legume species we found a new species that we named *Lathyrus belinensis*.
- Single population growing alongside new road between Kumluca and Tekirova, especially around an ungrazed village graveyard in 1987 and other have searched elsewhere but it has not been found from this location
- Species was a member of *Lathyrus* section *Odoratus* related to *L. odoratus* (sweet pea) but with yellow flower, so we bred a yellow sweet pea
- Attending a conference in Antalya, Turkey across to see my species completely destroyed by earth filling of a new police station
- Although a few plants were found in the area and seed is held *ex situ*, the richest area within the range had been lost.
- To draw attention to the species I applied the IUCN Red List Criteria and found to be **Critically Endangered**—the most highly threatened category
- The species has significant economic potential but is very near extinct in the wild. Only time will show if action can be taken before we lose the opportunity to fully exploit this natural resource!

IT IS OF GLOBAL and EUROPEAN IMPORTANCE THAT CWR ARE CONSERVED FOR USE

